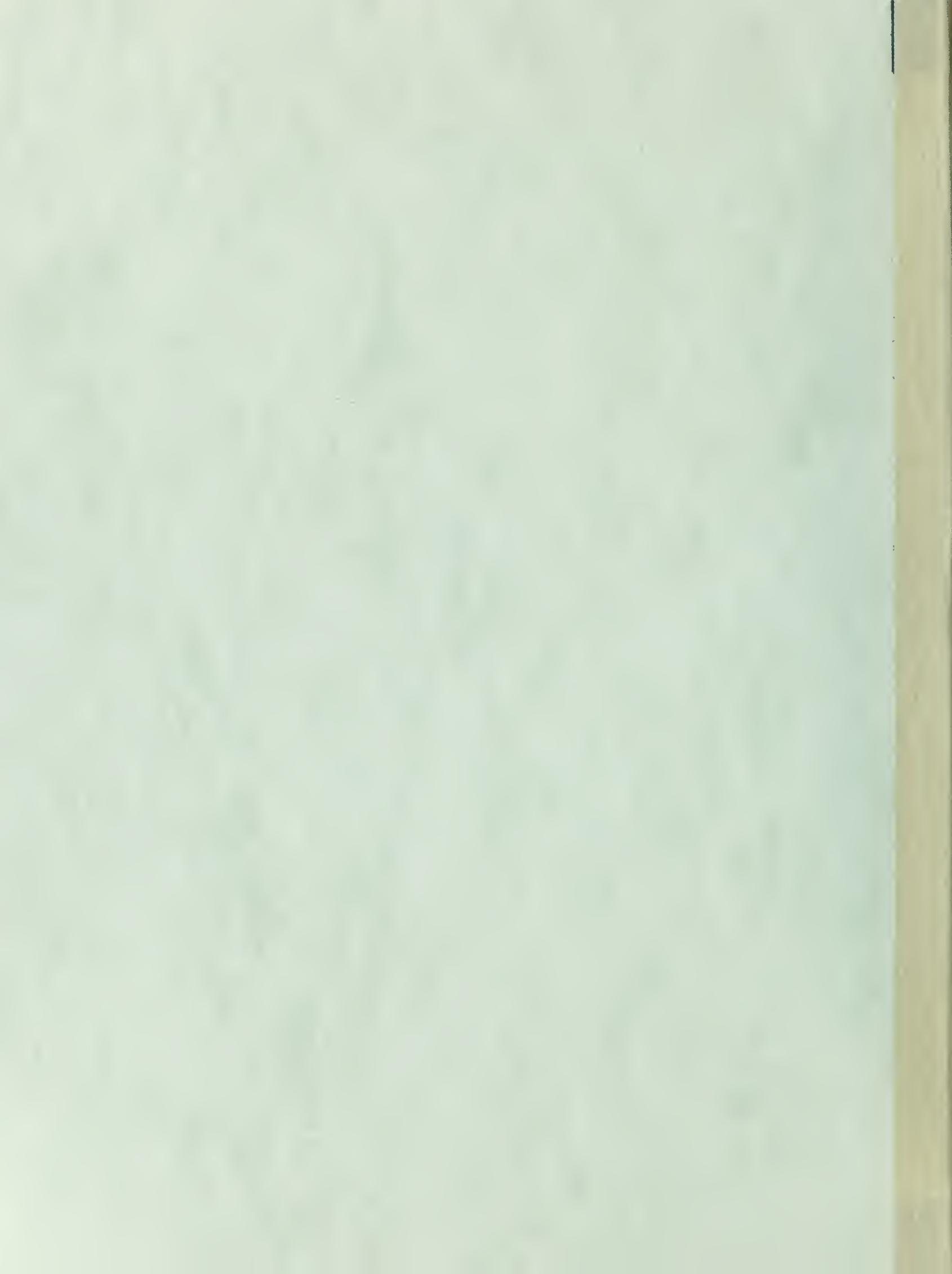


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ILLINOIS LAWN CARE AND ESTABLISHMENT

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THE LAWN IS ONE OF THE MOST IMPORTANT COMPONENTS OF THE landscape. It enhances the beauty of other ornamental plantings as it provides an attractive setting for the home, business, school, or recreational site. Lawns also reduce mud, dust, heat, noise, and glare. To develop and maintain an attractive lawn, certain cultural practices such as mowing, watering, and fertilizing should be performed regularly. Weeds, insects, and diseases should be controlled soon after the early signs of their development. Other problems, such as thatch and severe compaction of the soil, should be reduced by whatever means are appropriate to prevent deterioration of the lawn.

ESTABLISHING A LAWN

Many problems encountered in caring for a lawn can be avoided or reduced by paying close attention to certain procedures when the lawn is established. The following steps are important in developing a new lawn:

- Control weedy perennial grasses such as quackgrass and bentgrass.
- Rough-grade the area to be planted so that it has the desired slope and uniformity of surface.
- Make soil modifications if needed.
- Apply lime and "basic" fertilizer (see page 2) if soil test results indicate deficiencies.
- Plow, rototill, disc, or otherwise work the soil to a depth of 6 inches.
- Remove stones and other debris.
- Smooth-grade the area to achieve a uniform surface free of depressions and high spots.
- Apply "starter" fertilizer and rake it into the soil surface.
- Plant seed, sod, or other vegetative materials.
- Rake the seedbed lightly, allowing some seed to remain on the surface.
- Mulch the seedbed with weed-free straw or other suitable material.
- Water the seedbed and keep it moist until plant growth is well established.

Preparing the site

Perennial weedy grasses such as bentgrass and quackgrass will reappear and detract from the appearance of the new lawn if they are not controlled prior to establishment. A single application of a suitable herbicide¹ may be adequate to control most perennial grasses. Quackgrass, however, may require several applications of herbicide in conjunction with tillage to kill the subsurface rhizomes.

If the area requires extensive grading, remove the topsoil and stockpile it nearby; the underlying subsoil can then be shaped to the desired contour. Generally, a 2- to 3-percent slope away from buildings is recommended for proper surface drainage. Steep slopes should be avoided if possible, since it is difficult to establish and maintain lawn turf on these areas. After rough grading, redistribute the topsoil uniformly over the site.

Extensive soil-moving operations — especially those related to installing drainage, sewer, and water lines — may result in uneven settling and, consequently, a nonuniform surface. After such operations be sure to allow enough time for the soil to settle. Careful packing and several thorough waterings will help the settling process.

Modifying the soil

Turfgrasses can survive and persist on almost any soil, provided nutrients, water, and aeration are adequate. A sandy loam to loam soil, however, is preferred since turfgrass quality is generally better and management requirements are less stringent. An existing soil may be considered unsuitable because of poor drainage (as in clayey soils) or poor water- and nutrient-retaining capacity (sandy soils). On turfed soils subjected to heavy traffic, resistance to compaction is a highly desirable characteristic. Most soils can be modified to improve their physical properties significantly.

¹ Refer to Illinois Circular 1076, "Turfgrass Pest Control."

To improve aeration and drainage and to reduce the potential for compaction, soils high in clay may be diluted with organic matter (peat, rotted sawdust, etc.), sand, or other coarse aggregates such as calcined clay. A fibrous peat (sphagnum) is preferred over muck, as the latter frequently contains large amounts of dispersed clay and silt that may clog soil pores and actually reduce drainage and aeration. Sand should be used to amend an existing soil only if enough sand is available to make a resulting mixture that is at least 50 to 80 percent sand. Smaller quantities may actually do more harm than good, and the resulting mixture may be more compactable than the original soil. Calcined clay, a synthetic material formed by firing clay granules at very high temperatures, may be substituted for sand on a one-for-one basis. The quantities required and the cost of calcined clay or sand may limit their use for soil modification.

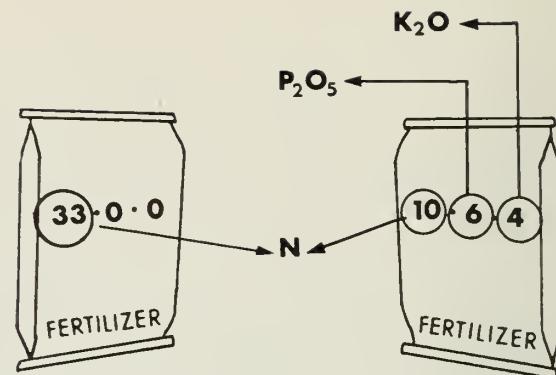
Drouthy, sandy soils may be improved with the addition of organic matter or finer textured mineral soils. A 2-inch layer of these additive materials, incorporated to a total depth of 6 inches, may substantially improve the water-holding capacity of the original soil and also provide for better storage of essential plant nutrients. Alternatively, enough soil of more desirable properties can be purchased to cover the existing soil by at least 6 inches. This is usually the most expensive method of soil amendment and, depending upon the quality of available soil, may not be the best answer. Any additional soil purchase should be free of quackgrass rhizomes and vegetative plant parts of other undesirable perennial grasses, for if such grasses develop in the new lawn, they cannot be controlled selectively with the herbicides presently available.

Under a vigorously growing turf, soil conditions generally will eventually improve without soil modification. This is a relatively slow process, however, and may be offset by the compacting effects of severe traffic.

Fertilization and liming

"Basic" fertilizer materials include phosphorus (P) and potassium (K). These should be incorporated into the seedbed as the soil is being tilled. The specific amounts of each nutrient should be based on soil test results. Take soil samples from a depth of 6 inches (tillage depth) and from several locations so that the total sample is representative of the area to be established.¹ Superphosphate (0-20-0) and muriate of potash (0-0-60) are suitable for correcting deficiencies in these basic nutrients (see Fig. 1). When soil test information is not available, a general recommendation is 1½ to 2 pounds of P₂O₅ (7½ to 10 pounds of 0-20-0) and the same amount of K₂O (2½ to 3 pounds of 0-0-60) per 1,000 square feet. (See also page 6 for

¹ For information on interpreting soil test results, refer to "Fertilizer Recommendations for Turf," H-690, available from the Horticulture Department, 124 Mumford, Urbana 61801, or contact your local county agricultural extension adviser.



In describing the analysis of a fertilizer, the first number refers to the percent of nitrogen present, the second number refers to the percent of P₂O₅ (phosphorus as phosphorus pentoxide), and the third to the percent of K₂O (potassium as potash). A "complete" fertilizer contains N, P, and K. (Fig. 1)

calculating amounts of fertilizer.) There is little value in incorporating soluble nitrogen deeply into a soil, since much of it may be leached out of the root zone before the turfgrass is sufficiently well developed to utilize it.

The ideal soil pH for most turfgrasses is 6.0 to 7.0. Lime (ground agricultural limestone) should be applied only if the soil test indicates that the pH is below 6.0. The amount of lime applied should be based on soil test results. Avoid excessive application rates, as too much lime may be more detrimental than too little. If lime is added, incorporate it with the basic fertilizer materials, using a band-type fertilizer spreader. Rotary spreaders are suitable for applying most granular fertilizers but not finely-ground limestone.

Preparing the seedbed

The first step in the actual preparation of the planting bed is to work the soil to a depth of 6 inches (Fig. 2). This provides sufficient soil porosity so that initial



Soil tillage operation.

(Fig. 2)

growth and development of the grass plants will not be restricted.

Rough-grade the seedbed to make it as uniform as possible (Fig. 3). Surface irregularities make maintaining a uniform and attractive turf difficult. Low spots or depressions tend to collect water and remain wet longer than surrounding areas. High spots, because they tend to dry out faster, show symptoms of wilting (moisture deficiency) sooner than adjacent areas. Careful attention to final grading reduces for many years the problems of maintaining the lawn. It is sometimes advisable to roll the soil during final grading so that low spots or irregularities will be well delineated and thus easier to correct.

A "starter" fertilizer should be applied at this time. This need be only nitrogen if phosphorus has already been incorporated into the soil but may also include P_2O_5 and K_2O , as in a "complete" fertilizer. Generally, 1 to 2 pounds of actual nitrogen per 1,000 square feet is adequate to supply the needs of the developing turfgrass plants (for example, 10 to 20 pounds of a 10-6-4 fertilizer or 3 to 6 pounds of 33.5-0-0 fertilizer). The fertilizer may be raked into the soil surface alone or with the grass seed.

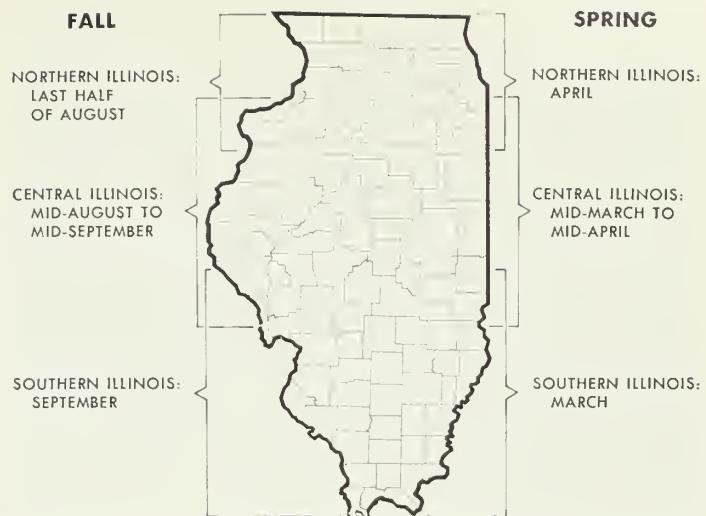
Planting the lawn

Seeding. The best time for seeding a new lawn is during late summer to early fall (see Fig. 4). Soil moisture and temperature are most favorable for rapid grass establishment then, and weed competition during the early development of the lawn is generally less severe. Early spring seeding is an alternative, but excessive soil moisture and severe competition from annual weeds can threaten successful lawn establishment during the spring. Midsummer plantings are frequently unsuccessful because of high temperatures, drouth, weed competition, and disease.

A good seedling stand is dependent upon proper care in placing the seed. Distribution should be as uniform



Preparing the final grade. (Fig. 3)



Probable best times for seeding cool-season grasses. (Fig. 4)

as possible and at the recommended rate for the specific lawn grass planted. (See page 5 for a discussion of grass species and seeding rates.) This is best done by a mechanical seeder or fertilizer spreader (Fig. 5), although hand application may be suitable, depending upon the skill of the applicator. An even distribution is more likely if half of the seed is applied in an east-west direction and half in a north-south direction.

After seeding, rake the area lightly to partially cover the seed (Fig. 6). Not more than one-quarter inch of soil should cover turfgrass seeds. Then roll the seeded area lightly (Fig. 7) to firm the surface and to provide good contact between the seed and the soil.

Mulching is recommended to reduce drying of the seedbed and to provide a more suitable environment for germination and early seedling development. In addition, mulching helps reduce erosion due to wind or rain. Straw is most commonly used and should be spread uniformly over the seeded area at the rate of



Seeding operation. (Fig. 5)



Raking the seedbed lightly.

(Fig. 6)

50 pounds per 1,000 square feet. The straw should be free of weed seeds and vegetative plant parts (such as rhizomes and stolons) of weedy perennial grasses. Once applied, the straw can be kept in place to some extent by rolling and watering. If winds tend to blow the straw away, twine staked over the area or an asphalt spray can be used to hold the straw down. It is not necessary to remove the mulch since it will decompose as the lawn develops.

Watering is essential to grass seed germination and seedling survival. The amount and frequency of required irrigation depends upon several environmental factors, including soil type, wind, temperature, and sunlight intensity. Generally, light watering two or three times a day for the first three or four weeks should be adequate. More frequent irrigation may be necessary on hot, windy days to compensate for faster evaporation of water from the soil surface. Use a nozzle or other device to break up the water stream into a fine mist. This is less damaging to soil structure and helps avoid washing seeds away. About three or four weeks after seeding, the turfgrass plants should



Rolling to firm the seedbed.

(Fig. 7)

have developed an adequate root system so that watering frequency can be reduced.

Sodding. An alternative to seeding is the installation of a previously established turf as sod. This can be done at any time during the growing season following soil preparation. The sodbed should be prepared in the same manner as a seedbed except that, to promote rapid rooting, the surface of the sodbed should be moist when the sod is laid. Sod pieces should be laid with the edges fitted snugly together and the ends staggered so that there will be no cracks in the surface. The sod should not be stretched excessively, as this may result in shrinkage and openings in the surface during drying. Once in place, the sod should be rolled to ensure good contact with the underlying soil. This will remove air pockets, which cause drying of the roots. On steep slopes the sod should be pegged in place so it won't slip. The newly sodded lawn should be watered thoroughly immediately after laying. Water daily thereafter to maintain adequate surface moisture during the rooting period of two or three weeks.

Vegetative planting. Other means of establishing a lawn include using stolons, plugs, and sprigs. These are used to produce a turf when seed is scarce or when a particular grass does not come true from seed. In Illinois, some bentgrass lawns are started with shredded sod in which the surface runners or stolons take root and produce new plants. The shredded material should be applied uniformly over the area at the rate of 2 to 10 bushels per 1,000 square feet. Additional soil is placed over the stolons to partially cover them, and the area is rolled to firm the surface. These small pieces of plant material are very susceptible to drying, so more watering is necessary with this method.

Plugs are small pieces of sod two or more inches wide. They are generally placed 1 or 2 inches deep in the soil, spaced 6 to 12 inches apart. Zoysiagrass and some Kentucky bluegrass varieties are available as plugs. Soil should be packed firmly around the plugs after planting and the area watered thoroughly to prevent drying. Moderate watering every two or three days is normally adequate for proper establishment.

Sprigs are individual plants or small clusters of plants used for vegetative establishment of a lawn. They are planted in slits 2 or 3 inches deep and 6 to 12 inches apart. The sprigs should be arranged in a more or less continuous line within the slit and placed so that the upper third of a plant is above soil level. Backfill the slits with soil, then roll to ensure good soil contact with the plant material. Water requirements are essentially the same as for plugs.

Care after planting

A newly planted lawn should be mowed when the foliage has grown to about 50 percent higher than the height desired after mowing. For example, a lawn that is to be maintained at a height of 2 inches should receive its first and all subsequent mowings by the time

it reaches 3 inches. A lawn mower should always be sharp for best mowing quality. This is especially important for the first few mowings, since the young grass seedlings can easily be pulled out of the soil by a dull mower. Early establishment is hastened by applying $\frac{1}{2}$ to 1 pound of nitrogen per 1,000 square feet when the young seedlings are 2 inches high. The fertilizer should be applied to dry grass and watered immediately to preclude burning. Any injury from spilled or improperly applied fertilizer is often serious, since the young grass is not sufficiently developed to recover easily.

Lawns seeded in late summer or early fall may be relatively free from severe weed competition during the critical establishment period. Lambsquarters and pigweeds are usually eliminated by mowing, and annual weeds are killed by the first frost. Occasionally, however, some annual grasses and broadleaved weeds may be troublesome, especially in spring-seeded lawns. Applications of 2,4-D and related herbicides for controlling broadleaved weeds should be delayed until the grass has received at least two or three mowings (until six to eight weeks after seeding). A preemergence application of siduron, applied at the time of seeding, is useful in preventing infestations of crabgrass and other annual weeds. Applications of postemergence herbicides

for controlling annual weedy grasses should be delayed for at least two months after planting.

Leveling the new lawn

Lawns established on a firm and uniform seedbed may not require leveling unless a very close mowing height is used. Frost heaving during the early period of development, however, may necessitate rolling or topdressing to smooth the surface. A lawn roller filled approximately one-third with water is generally satisfactory for eliminating small irregularities in the surface. To avoid severely compacting the soil, the ground should be fairly dry when rolled.

If large ridges and depressions develop, the problem cannot be solved by rolling. Intensive rolling may simply compact the soil and cause a marked deterioration of the lawn. A better solution is to lift the sod, add or remove soil, and replace the sod.

Localized topdressing may also be used to smooth the lawn surface. Several light applications of screened soil can be applied and worked into the turf with a heavy steel mat or flexible rake. The topdressing soil should be as nearly identical to the underlying soil as possible to prevent layering. Not more than one-quarter inch of soil should be applied at any one time — more may smother the grass.

SELECTING THE RIGHT GRASS

Careful selection of turfgrass species and varieties is important in developing a lawn that will fulfill the purpose for which it is intended. The cost of grass seed or vegetative planting materials is low, considering how long the lawn will be in existence or how much time and money will be spent on its maintenance. Using the wrong grass for a particular environment, intensity of maintenance, or use will likely result in failure or an inferior quality turf.

The seedbag tag provides specific information on the percent purity and germination as determined in laboratory tests. The percentage of weeds and other crop seed is also listed. Best results from seeding are usually expected with seed containing no weeds nor other crop seed such as bentgrass, redtop, or annual bluegrass. The higher price paid for quality seed is a good investment.

The principal lawngrasses used in Illinois are Kentucky bluegrass and red fescue. The many varieties that exist within these species display marked differences in color, texture, and disease susceptibility. In general, however, Kentucky bluegrasses are usually best adapted for use in open, sunny locations, while red fescues are more suited to shaded environments. Environmental variation is the principal reason for combining different grasses for seeding. Combinations of several varieties within a species are referred to as "blends"; a combination of two or more species is a "mixture." Blends of Kentucky bluegrasses offer the advantage of potentially greater adaptation to a broad

range of conditions, while pure stands of selected varieties generally provide the finest quality turfs. Mixtures of Kentucky bluegrass and red fescue are used for shady locations or where there are wide variations in sunlight intensity. This combination is also suggested

Seeding Rates for Lawn Establishment

| Pure Stands | | |
|--------------------|-----------------------|---------------------------------|
| Grass species | No. of seed per pound | lb. of seed per 1,000 sq. ft. |
| Kentucky bluegrass | 2,200,000 | 1 to 3 |
| Red fescue | 600,000 | 3 to 4 |
| Bentgrass | 6,000,000 | $\frac{1}{2}$ to $1\frac{1}{2}$ |
| Tall fescue | 250,000 | 6 to 8 |
| Perennial ryegrass | 250,000 | 4 to 5 |

| Mixtures and Blends | | | |
|---------------------|--------------------|---------------------|-------------------------------|
| Condition | Grass species | Percent composition | lb. of seed per 1,000 sq. ft. |
| Shady | Red fescue | 50 | 3 to 4 |
| | Kentucky bluegrass | 50 | |
| Steep slopes | Perennial ryegrass | 25 | 2 to 3 |
| | Kentucky bluegrass | 75 | |
| Sunny | Kentucky bluegrass | equal parts of each | 1 to 3 |
| | | | |

for low-quality lawns that will receive minimal maintenance.

Ryegrass and redtop are frequently found in seed mixtures. They germinate several days after planting and provide quick cover. However, they tend to persist in the lawn as unsightly weeds for several years. They are not recommended for use with Kentucky bluegrass unless a quick cover is absolutely necessary for erosion control or a midseason seeding is demanded. If required, use only perennial ryegrass (not redtop) at no more than 25 percent of the seed mixture.

Tall fescue is used as a low-maintenance grass where its coarse texture is not objectionable. It should not be mixed with Kentucky bluegrass as it will tend to "bunch" and become a serious weed in the lawn.

Bentgrass is the finest quality turfgrass available, provided it receives meticulous care. It is not recom-

mended for use in most home lawns because of its stringent maintenance requirements.

Rough bluegrass or *Poa trivialis* may be found in some grass seed mixtures because of its adaptation to moist, shaded conditions. However, it does not blend well with other turfgrasses and lacks traffic and drouth tolerance. It may actually form dense patches that look similar to bentgrass. It is not recommended except in moist, shaded sites where red fescue will not persist.

Varieties of a specific turfgrass vary considerably in terms of disease resistance, mowing tolerance, and other factors. In recent years, many new varieties have been introduced for commercial distribution, and others now in the experimental stage will soon be available. Consult your local county extension adviser or the University of Illinois turfgrass specialist for the most recent recommendations.

FERTILIZATION

The lawn is a dynamic and complex community of plants that requires an adequate level of soil fertility to maintain aggressive growth. Proper fertilization is important for the production of a healthy, dense stand of grass that will resist weeds and recover quickly from disease and insect injury.

Fertilizer calculations

An application of 1 pound of nitrogen per 1,000 square feet of lawn area requires 10 pounds of 10-6-4 fertilizer, 5 pounds of 20-5-10 fertilizer, or 3 pounds of 33-0-0 fertilizer. This is determined by dividing the desired nitrogen application rate by the nitrogen percentage of the fertilizer, then multiplying by 100. Thus, to apply a 23-7-7 analysis fertilizer at the rate of 1½ pounds of nitrogen per 1,000 square feet, calculate as follows:

$$\frac{1\frac{1}{2} \text{ lbs. N}}{23} \times 100 = 6\frac{1}{2} \text{ lbs. of 23-7-7}$$

In this case, 6 ½ pounds of the fertilizer is required to supply 1½ pounds of nitrogen to a lawn of 1,000 square feet. For a lawn that measures 8,500 square feet, continue the calculations as follows:

$$\frac{6\frac{1}{2} \text{ lbs. of 23-7-7}}{1,000 \text{ sq. ft.}} \times 8,500 \text{ sq. ft.} = \frac{55 \text{ lbs. of 23-7-7}}{\text{for the total area}}$$

Thus, a 50-pound bag of this fertilizer would be just about right to fertilize a lawn that measures 8,500 square feet at the rate of 1½ pounds of nitrogen per 1,000 square feet.

The same calculation method applies to other nutrients found in a fertilizer. For example, a 0-20-0 analysis fertilizer contains no nitrogen or potassium but does have 20 percent phosphoric acid. The amount of this fertilizer required to apply 1 pound of phosphoric acid per 1,000 square feet is determined as follows:

$$\frac{1 \text{ lb. P}_2\text{O}_5}{20} \times 100 = 5 \text{ lbs. of 0-20-0}$$

Potassium may also be found alone or in mixed fertilizers. Muriate of potash (0-0-60) may be used when only potassium is desired. For example, to apply 1 pound of potash per 1,000 square feet, use the following calculation:

$$\frac{1 \text{ lb. K}_2\text{O}}{60} \times 100 = 1.7 \text{ lbs. of 0-0-60}$$

The specific amounts of P_2O_5 and K_2O required for a good lawn are best determined from soil test results. The optimum rate of nitrogen fertilization, however, is based on several factors, including the species and varieties of grass in the lawn, the type of soil, and the conditions under which the lawn is maintained.

Soil testing

Soil should be tested by a reputable laboratory every three to five years. The results will indicate whether deficiencies of phosphorus or potassium exist in the soil and, if so, how much of these nutrients should be supplied to the soil. The soil test is also a valuable tool for determining the suitability of your present fertilization program.

Select a dozen or more small soil samples from various parts of the lawn, using a narrow garden tool or soil probe. In an established lawn, extract samples to a depth of 3 inches. Mix all samples, air dry, and send approximately half a pint of the soil to the soil testing laboratory. Consult your local county agricultural extension adviser for the locations of soil testing facilities in your area.

Soil tests also usually determine soil pH. This indicates whether lime should be applied to correct for high soil acidity — a factor that can reduce the benefits from fertilization. See page 2 for more about lime.

Nitrogen fertilization

Turfgrasses are more responsive to nitrogen than to any other nutrient. It should be applied at least twice a year, but three or four times a year is preferable for maintaining a high-quality lawn. Suggested annual application rates of nitrogen are given below. Ranges of application rates are indicated because of variations in climate, soil, and cultural conditions.

Because nitrogen is readily leached from the soil, periods of high rainfall or intensive irrigation may necessitate using a higher rate of nitrogen fertilization, especially on sandy soils. If grass clippings are removed with mowing, additional nitrogen and other nutrients should be supplied to compensate for the loss. The nitrogen requirement of a turf may be reduced by an estimated 20 percent or more if clippings are returned.

It is advisable to limit individual applications of soluble nitrogen to no more than 2 pounds per 1,000 square feet of lawn area. Higher rates can chemically burn the grass, cause excessive foliar growth, and increase the susceptibility of grass to injury from diseases and temperature extremes. Apply fertilizer uniformly over the lawn when the foliage is dry, and water it immediately to avoid chemical injury. Good results are generally obtained from split applications of the fertilizer: apply half the amount of fertilizer over the lawn, then apply the rest to the lawn at right angles to the original direction of application.

Suggested Annual Nitrogen Fertilization Rates for Turfgrasses in Illinois

| Grass species | Pounds of nitrogen per 1,000 square feet |
|--|--|
| Kentucky bluegrasses | |
| Improved varieties ^a | 4 to 6 |
| Common-type varieties ^b | 2 to 4 |
| Creeping bentgrass | 4 to 6 |
| Tall fescue ^c | 3 to 5 |
| Fine-leaf fescues ^d | 1 to 3 |

^a Improved varieties of Kentucky bluegrass include A-20, A-34, Adelphi, Baron, Bonnieblue, Fylking, Merion, Nugget, Pennstar, Sodco, and Windsor.

^b Common-type Kentucky bluegrasses include Delta, Kenblue, Park, and Newport.

^c Tall fescue is generally regarded as requiring little fertilization; however, it does respond well to increased fertilization.

^d Use the lower amount for fine-leaf fescues grown in shade. Fertilize trees separately by soil injection.

Forms of nitrogen

Nitrogen is available in several forms for fertilizing lawns: water-soluble, slowly-soluble, and slow-release. *Water-soluble* nitrogen occurs in such common materials as ammonium nitrate, ammonium sulphate, and urea. These provide a quick response after application and are the least expensive nitrogen fertilizers, compared to the other forms available, but they have a high potential for causing chemical injury.

Slowly-soluble forms of nitrogen include natural organics (activated sewage sludge and animal products) and synthetic organics (UF and IBDU). These materials break down slowly so that nitrogen becomes available to the grass gradually. Although more expensive per pound of nitrogen than the water-soluble forms, the slowly-soluble forms provide a greater margin of safety because they do not readily cause chemical injury to the grass.

Slow-release nitrogen is actually a water-soluble form of nitrogen coated with plastic or other membranes to restrict contact with moisture. This is the most expensive form of nitrogen, but its characteristics of gradual availability and safety to the plants are desirable in a lawn fertilization program.

Regardless of the type of nitrogen used, fertilizer applications should be timed to provide maximum benefit to the lawn with a minimum risk of plant injury. Water-soluble nitrogen should be applied in small amounts during mid-spring after the grass has resumed growth and during late summer. Use 1½ to 2 pounds of actual nitrogen for each of these applications. For a high-quality lawn, supplement with applications at half these rates during late spring and midsummer. Slowly-soluble and slow-release fertilizers can be applied at rates as high as 3 to 4 pounds of actual nitrogen per 1,000 square feet. Two applications of these latter two materials per year will generally be adequate to sustain healthy, vigorous growth.

Fertilizer spreaders

Fertilizer spreaders are of two principal types: rotary and band-type. The rotary spreader (Fig. 8) employs a rotating disc to distribute the fertilizer well beyond the width of the spreader. This type is very efficient for covering a large area, and uniformity of application is generally good.



Rotary-type spreader for applying granular fertilizers to the lawn.
(Fig. 8)

The band-type spreader (Fig. 9) applies the fertilizer directly beneath the spreader, usually in a 1½- to 3-foot width. Accuracy of application is good, but take care to avoid misses.

Both types of spreaders should be calibrated at least every year to ensure that fertilizers are being applied at the desired rates. Calibration simply means determining the application rate of a spreader at specific settings. A suggested method is to mark off an area of 20 x 50 feet (1,000 square feet); then, place a weighed amount of the fertilizer in the spreader and apply to the area at a specific spreader setting. Measure the amount of fertilizer remaining in the spreader and subtract from the original amount. This difference is the amount of fertilizer applied to 1,000 square feet of lawn. Re-adjust the spreader setting until the desired amount has been applied. Record this setting and be sure to check it with the calibration procedure each spring before making the first application of fertilizer. To ensure accuracy of application, the spreader should be calibrated for each fertilizer used.



Band-type spreader for applying granular fertilizers and agricultural limestone to the lawn. (Fig. 9)

MOWING

A quality lawn requires regular mowing at the correct cutting height with suitable equipment. Proper mowing is essential to developing and maintaining a dense, uniform surface and can effectively reduce the number of weed species that may invade a lawn.

Height of cutting

Selecting the correct mowing height depends primarily upon the species of grasses in the lawn. The appropriate cutting heights for common lawn grasses are as follows:

| <i>Grass</i> | <i>Cutting height</i> |
|----------------------|-----------------------|
| Kentucky bluegrasses | 1½" to 2½" |
| Red fescues | 2" to 2½" |
| Ryegrasses | 2" to 2½" |
| Tall fescues | 2½" to 3" |
| Bentgrass | ¼" to ¾" |
| Zoysiagrass | ½" to 1" |

Cutting the grass too short weakens the turf and increases susceptibility to weed invasion, diseases, insect damage, and injury from drouth and temperature extremes. Alternatively, if the grass is cut too high, it often has a shaggy, nonuniform appearance that substantially detracts from the lawn's attractiveness.

Cutting height and rate of growth, rather than fixed time intervals, should determine mowing frequency. As a general rule, do not remove more than a third of the total foliage at any one mowing. For example, if the selected mowing height is 2 inches, the grass shouldn't grow to more than 3 inches high before it is mowed. Removing more than a third of the foliage results in an open, stemmy appearance of the lawn and may substantially reduce root growth, especially under mid-summer conditions.

Removing clippings

Because they return essential plant nutrients and organic matter to the soil, clippings, if not excessive, are actually beneficial. Removing them is unnecessary unless there are so many that they do not readily sift down into the turf when dry. The amount of clippings will be minimized by mowing at the proper frequency. If large clumps of grass clippings do result, however, remove them to avoid smothering the turf and to prevent disease problems.

Mowing equipment

There are two principal types of mowers for use on home lawns: reel and rotary.

Reel mowers (Fig. 10) cut with a shearing action and, if properly sharpened and adjusted, give a high-quality cut. Improper adjustment makes the lawn surface appear uneven; upon close examination, moreover, the grass leaf ends may appear brown and stringy. (Grass leaf ends may also have that appearance if the cutting edge is dull or if it has been nicked by small stones or other debris.)

The adjustment and sharpness of the cutting edges can be checked by the following procedure:

1. Rotate the mower backwards until it rests on the handle.
2. Place a strip of newspaper between the reel knife and the bed knife.
3. Slowly rotate the reel to cut the paper.

The reel should rotate smoothly with very little pressure, cutting the paper cleanly. If the reel does not rotate smoothly or a clean cut is not obtained, adjust the unit by following the directions on the instruction sheet that came with the mower.



Reel mowers cut with a shearing action because of contact between the reel blades and the bed knife. (Fig. 10)

The cutting height of the mower should be checked frequently. Stand the mower on a flat surface and with a small ruler measure the distance between the surface and the upper edge of the bed knife. The cutting height may be changed by raising or lowering the castings that hold the roller at the rear of the unit.

Rotary mowers (Fig. 11) have become very popular because of their low cost and ease of handling. They are also, however, very dangerous if not used properly. The rapid rotation of the rotary blade may project stones and other debris quite forcefully for long distances, injuring animals and humans as well as damaging property. To prevent needless accidents, check for loose debris in the lawn before mowing. Keep



Rotary mowers cut with an impact action because of the high rotation velocity of the cutting blade about a vertical shaft. (Fig. 11)

fingers and toes well away from the underside of the rotary mower housing when the engine is running. A good safety precaution is to remove the spark plug wire from the spark plug after use and before making any adjustments on the mower.

The cutting height of rotary mowers is adjusted by raising or lowering the wheels. Place the mower on a flat surface and measure the height of the cutting blade from the surface. Raise or lower the wheels until the desired height is achieved.

Rotary blades should be removed and sharpened frequently to ensure a clean cut. A dull blade simply tears the grass leaves and may eventually cause a deterioration of turfgrass quality.

IRRIGATION

Adequate water is essential for maintaining optimum growth, density, and color. Natural rainfall is generally adequate during the cool spring and fall periods; however, extended drought periods during summer may cause the grass to wilt and turn brown. Although it may look unattractive, a lawn that is brown and dormant in summer will usually recover with the return of cooler weather.

If a high-quality appearance is desired throughout the season, the lawn should be irrigated as soon as the grass shows signs of wilting. Apply enough water to moisten the soil to a depth of at least 6 inches. This is roughly equivalent to applying an inch of water. The amount of water supplied can be measured by placing

coffee cans or other suitable receptacles within the area covered by the sprinkler.

Light, frequent irrigations lead to deterioration of the lawn because of shallow rooting and increased disease, weed development, and insect damage. Irrigate the lawn area uniformly; avoid puddling, as this may scald the grass when temperatures are high. If the soil is so compacted that it does not absorb the water readily, extend the application period by moving the sprinkler back and forth over the area. The lawn may be watered at any time during the day as long as the application rate does not exceed the infiltration capacity of the soil. To reduce the potential for diseases, however, the preferred time is early morning to midday.

CONTROLLING TURFGRASS WEEDS

A dense, vigorous stand of grass is the best defense against invading weeds. This can be achieved by following the recommendations in the other sections of

this circular. When weeds do occur, however, timely applications of specific herbicides will reduce or eliminate them from the lawn. Herbicides alone will not

produce a good lawn — their use must be accompanied by basic improvements in the lawn care program. Otherwise, weeds will probably reinfest the lawn or be replaced by other weeds that are more difficult to control.

Injury from insects, disease, misuse of fertilizers or pesticides, or excessive wear weakens the turfgrass community and allows weeds to become established. Prevention and immediate repair of lawn injury are important weed control measures.

Weeds are often good indicators of unsuitable growing conditions for lawn grasses. For example, extensive development of knotweed is frequently associated with severely compacted soil conditions. Although this weed can be selectively controlled with herbicides, the result of such treatment may be bare ground or the development of more weeds, unless soil compaction is reduced by appropriate means (see page 23).

Refer to the weed sketches and descriptions in the next section for weed identification and the conditions under which specific weeds may develop.

Broadleaf weeds

Most broadleaf weeds can be controlled selectively with postemergence applications of available herbicides. These chemicals are best applied during cool weather when the grass and weeds are actively growing; treatments during hot weather may injure the lawn grass. Control methods are most effective when the weeds are treated at an early stage of growth.

Most herbicides used for broadleaf weed control have very little residual activity, as they are readily broken down by soil organisms. Since the soil probably contains many weed seeds, new weeds will soon develop unless the grass fills in fairly rapidly. Hence, a good fertilization program and proper mowing are important in preventing reinfestation.

Annual grasses

Crabgrass, goosegrass, and foxtail (see pages 10 and 11) are annual grasses commonly found in lawns. They germinate during spring and early summer and die out with the first frost in fall. Poorly maintained lawns may appear to be completely taken over by annual grasses by midsummer. The most common annual grass in lawns is crabgrass, and many commercial herbicide formulations are available for controlling this weed.

Preemergence herbicides can be applied before the appearance of crabgrass in the lawn. These herbicides persist in the soil for several months and control crabgrass and other annual grasses through the growing season. The new shoots and roots of germinating seeds absorb the herbicide and are killed. Preemergence herbicides should be applied in early April, about the time forsythia is in bloom.

Postemergence crabgrass herbicides are applied after the crabgrass appears in the lawn. At least two weekly applications are required for complete control. These herbicides may cause some discoloration of the grass, but the injury is usually short-lived. Preemergence herbicides are generally ineffective once the crabgrass plants are visible in the lawn.

Perennial grasses

Any undesirable grass that persists in the lawn from year to year is a weed. Bentgrass and tall fescue, commonly used for lawns and other turfs, are quite acceptable when planted intentionally: in Kentucky bluegrass, however, they appear as unsightly clumps or patches and are serious weeds. Quackgrass and nimblewill are also undesirable perennial grasses in lawns.

Presently, there are no herbicides that will selectively control perennial grasses. Isolated clumps or patches of perennial grasses can be removed with a knife or a trowel or pulled by hand. Make sure that all plant parts, including subsurface rhizomes, are completely removed so the weed won't grow back. Large bare spots left when perennial grasses are removed should be sodded or seeded as soon as possible. Small pieces of sod from border areas of the lawn can provide desirable grasses quickly.

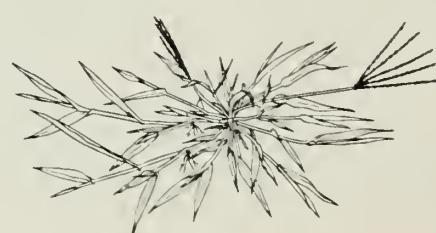
An alternative to removing perennial grasses by hand is spot-treatment with nonselective herbicides, in which an entire treated area is killed. Before seeding or sodding such an area, a waiting period of several weeks may be necessary to allow the herbicide to break down.

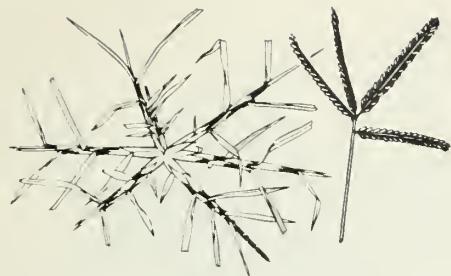
Extensive infestations of perennial grasses may require complete reestablishment of the lawn. Refer to pages 1-5 for details.

Specific herbicide recommendations for controlling lawn weeds are given in Extension Circular 1076, "Turfgrass Pest Control," available from the Publications Office, College of Agriculture, 123 Mumford Hall, Urbana, Illinois 61801, or from your local county extension adviser.

IDENTIFYING TURFGRASS WEEDS

Crabgrasses (*Digitaria ischaemum* and *D. sanguinalis*) are late-germinating annuals that reproduce by seed. The seedheads appear as several finger-like projections at the terminals of seedstalks. The spreading growth of crabgrass tends to crowd out desirable grasses in the lawn. Like other summer annuals, crabgrass is killed by the first frost, leaving unsightly dead patches in the turf.

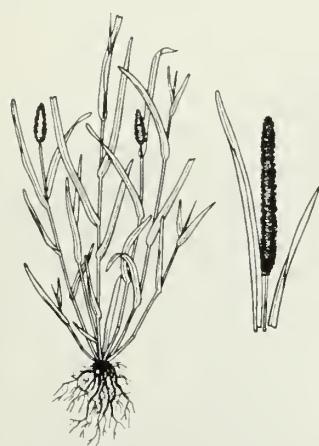




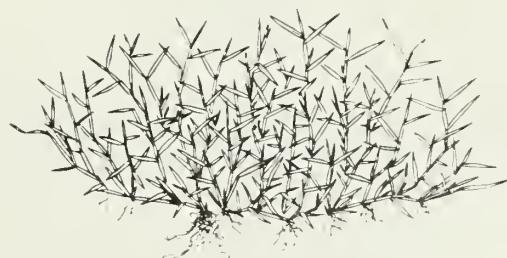
Goosegrass or silver crabgrass (*Eleusine indica*) is an annual that begins germinating several weeks after crabgrass. It is similar to crabgrass except that the center of the plant is a silvery color and the seedheads are zipper-like in appearance. It is frequently found in compacted and poorly drained soils.



Fall panicum (*Panicum dichotomiflorum*) is a late-germinating annual grass with short, purplish sheaths. The seedhead is an open and spreading panicle.



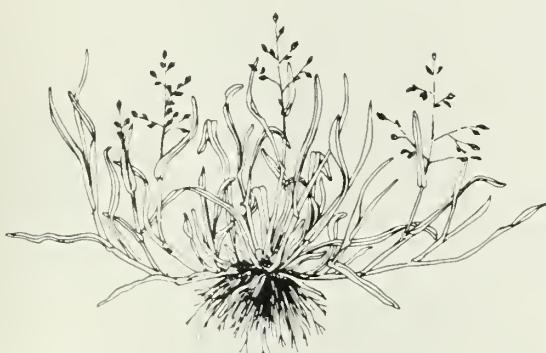
Yellow foxtail (*Setaria glauca*) is an annual grass frequently found in newly seeded lawns. It is identified by the presence of long hairs on the upper surface of the leaf blade near the base and by the yellow cylindrical seedheads.



Nimblewill (*Muhlenbergia schreberi*) is a creeping perennial grass that forms patches resembling bent-grass. Leaf blades are flat and short.



Bermudagrass (*Cynodon dactylon*) is a perennial grass commonly grown in the southern United States. Because of its vigorous and dense growth, it is a serious weed in bluegrass lawns. Leaves are hairy at the junction between the blade and sheath and on both sides of the blades.

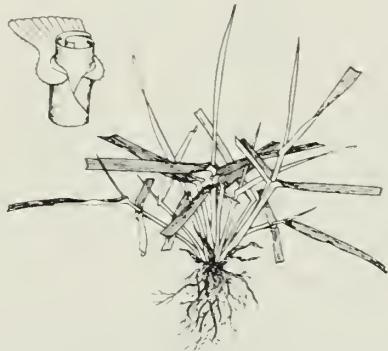


Annual bluegrass (*Poa annua*) is a winter annual or short-lived perennial that may predominate in a lawn growing under moist, shaded conditions and on compacted soils. It frequently is observed in dense patches of light green color. Seedheads are produced throughout most of the growing season but are especially abundant in mid-spring.



Bentgrass (*Agrostis palustris*) is a perennial grass that spreads by above-ground stems called stolons. It

forms puffy, dense patches that may completely take over the lawn. Provided it receives close, frequent mowing and meticulous care, bentgrass will make a very attractive lawn; otherwise, it is regarded as a serious lawn weed.



Tall fescue (*Festuca arundinacea*) is a coarse-textured perennial grass growing in unsightly clumps in the lawn. In pure stands, however, it may be an acceptable turf because of its good wear resistance and low maintenance requirement.



Quackgrass (*Agropyron repens*) is a perennial grass that spreads by underground stems called rhizomes. It may be identified in the lawn by its dull green color and its rapid foliar growth.



Nutsedge (*Cyperus esculentus*) is a perennial sedge that reproduces by seed, rhizomes, and small, hard tubers called nutlets. It is identified by its triangular stems and yellow-green color. The nutlets may persist in the soil for several years, ensuring regeneration of the plants.



Plantains (*Plantago major* and *P. rugelii*) are perennials that reproduce by seed. The leaves form a basal rosette with finger-like flower stalks protruding upward.



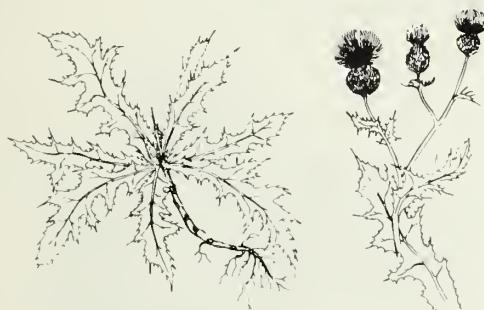
Buckhorn (*Plantago lanceolata*) is a perennial with lance-like leaves and bullet-like seeds on long, slender stems.



Dandelion (*Taraxacum officinale*) is a perennial that reproduces by parachute-like seeds. It is easily recognized by its sharply-lobed leaves. The flowers are bright yellow and turn into fluffy white seedheads.



Chicory (*Chicorium intybus*) is a perennial that reproduces by seed. The taproot is large and fleshy. A rosette of leaves resembling dandelion leaves form at the base. Bright blue flowers are borne on rigid stalks that resist mowing.



Thistles (*Cirsium* species) are perennials or biennials with spiny and serrated leaves. A rosette-type of growth typically occurs under mowing. The numerous and sharp spines make these weeds particularly objectionable in turf.



Red sorrel or sheep sorrel (*Rumex acetosella*) is a clump-type weed with arrow-shaped leaves. It often appears on acid soils low in fertility.



Ground ivy or creeping-charlie (*Nepeta hederacea*) is a creeping perennial that forms dense patches in

turf. Its bright green leaves are round with scalloped edges. Its flowers are bluish-purple and the stems are four-sided. It grows well in shady areas where soils are poorly drained.



Curled dock (*Rumex crispus*) is a perennial that reproduces by seed. It has a fleshy taproot and large, smooth leaves that are crinkled on the edges.



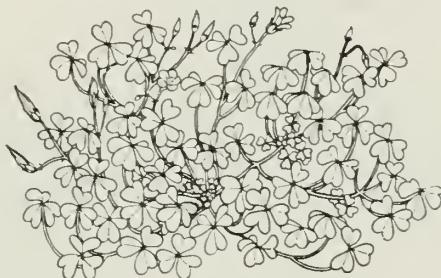
Henbit (*Lamium amplexicaule*) is an annual that reproduces by seed. The leaves resemble those of ground ivy but occur opposite along the stem.



Roundleaved mallow (*Malva neglecta*) is an annual or biennial that reproduces by seed. It has a long taproot and round leaves with five distinct lobes. Its white flowers first appear in late spring and bloom continuously through the season.



Yarrow (*Achillea millefolium*) is a fern-like perennial weed that spreads by rhizomes. Under close mowing, it forms a dense mat and is quite wear-resistant and drought-tolerant.



Yellow wood sorrel (*Oxalis stricta*) is a pale green annual or perennial that reproduces by seed. It has heart-shaped leaves, and its flowers are yellow with five petals.



Mouse-ear chickweed (*Cerastium vulgatum*) is a perennial that reproduces mainly by seed but also by creeping stems. It is identified by its small, fuzzy, dark green leaves and dense growth habit.



Common chickweed (*Stellaria media*) is a creeping winter annual with small, pale green leaves. Its hairy stems branch and take root, enabling the plant to spread

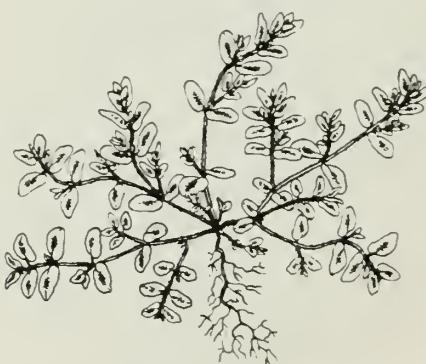
over large areas and completely crowd out turfgrasses. White star-like flowers appear during cool seasons.



White clover (*Trifolium repens*) is a creeping perennial that competes aggressively with established turfgrasses, especially under moist conditions and low soil fertility. It is identified by its three short-stalked leaflets and globular, white flowers.



Black medic or yellow trefoil (*Medicago lupulina*) is an annual, biennial, or perennial that closely resembles white clover. It is distinguished by its yellow flowers and the arrangement of its leaflets on the stem: the middle leaflet is borne on a short petiole while the lateral leaflets are close to the stem.



Prostrate spurge (*Euphorbia supina*) is a low-growing annual that generally appears in mid-season. The small leaves are opposite and frequently have a red blotch in the center. The stem oozes a milky sap when broken.



Knotweed (*Polygonum aviculare*) is a low-growing annual that first appears in early spring. Its appearance is variable, depending upon the stage of maturity. Young plants have long, slender dark green leaves that occur alternately along the knobby stem. Mature plants have smaller, dull green leaves and inconspicuous white flowers. It grows well on heavily trafficked, compacted soils.



Purslane (*Portulaca oleracea*) is a fleshy annual weed with smooth reddish stems. It may be particularly troublesome in new lawn seedings.



Carpetweed (*Mollugo verticillata*) is an annual with smooth, tongue-like leaves. Stems branch in all directions, forming flat, circular mats of growth.



Wild onion and wild garlic (*Allium* species) are perennial weeds with slender, cylindrical leaves. Wild garlic leaves are hollow; those of wild onion are not.

LAWN DISEASES

Luckily, of the more than 100 infectious diseases of lawn and fine turfgrasses, only a few are destructive. The lawn diseases commonly reported in Illinois and other midwestern states are caused by fungi, organisms that lack chlorophyll and so cannot manufacture their food by the process of photosynthesis. Most fungi that infect turfgrasses obtain their food from dead and decaying roots, stems, and leaves, either in the soil or in the thatch. Under favorable temperature and moisture conditions, living turfgrass plants are attacked, especially where the grass lacks vigor.

Fungi usually produce large numbers of microscopic spores that are spread by wind, water, mowers, infected grass clippings, and other agents. Before these fungus spores can germinate and cause infection, they need free moisture on grass surfaces and the proper air temperature. Lawn diseases, therefore, are most common and destructive in wet weather or after frequent light waterings.

Turfgrass diseases vary in severity from year to year and from one locale to another, depending upon the

environment (principally moisture conditions, temperature, humidity, and grass nutrition), the relative resistance or susceptibility of the grass plant, and the causal fungus. Good cultural practices help maintain healthy turf despite the presence of disease-causing organisms. Vigorous turf better withstands wear and recovers more quickly from injury.

The following cultural practices will greatly reduce lawn disease problems:

1. Provide good surface and subsurface drainage when establishing a new lawn. Fill in low spots. The seedbed should be well prepared, free of coarse debris, and fertile, with a pH between 6 and 7 (see page 2).
2. Grow locally adapted, disease-resistant grasses or combinations (blends and mixtures).
3. Buy top-quality, disease-free seed. When feasible, plant when the weather is cool and dry. Avoid overwatering and waterlogging the soil.
4. Fertilize on the basis of soil test results. Avoid overstimulation with nitrogen fertilizer, especially in hot weather and late in the fall.

5. Mow frequently at the height recommended for your area and for the grasses grown. Remove no more than one-third of the leaf surface at one cutting. Mow throughout the fall until the grass stops growing.

6. Water established turf thoroughly during drouths. Moisten the soil to a depth of at least 6 inches. Water as infrequently as possible. Avoid frequent light sprinklings, especially in late afternoon or evening.

7. Increase air flow and light by pruning or removing dense trees and shrubs that border turf areas.

8. Remove thatch in early spring or late summer, if it has accumulated to half an inch or more thick.

9. Cultivate compacted areas by coring or spiking (see page 23) and reduce traffic by strategic placement of walks, fences, shrubbery, etc.

10. Follow suggested insect- and weed-control practices for your area and for the grasses grown.

The more common lawn diseases in Illinois include *Helminthosporium* leaf spots and melting-out, leaf smuts, powdery mildew, *Fusarium* blight, *Sclerotinia* dollar spot, rusts, slime molds, and fairy rings. Typical symptoms and occurrence of these diseases are outlined below.

Additional information and chemical controls are outlined in "Lawn Diseases in the Midwest" (NC-12) and "Turfgrass Pest Control" (Extension Circular 1076), available at all county extension offices. A series of Reports on Plant Diseases is available from the Department of Plant Pathology, 218 Mumford Hall, Urbana, Illinois 61801.

***Helminthosporium* leaf spots or blights: crown and root rots (melting out)**

This is the most common and serious group of diseases in Illinois. One or more of the causal fungi attack all lawn and fine turfgrasses, producing a variety of symptoms.

Leaf spots or blights appear on the leaves from early spring to fall as small, dark brown, purplish, or purplish-red spots. The spots enlarge and develop light-colored centers with dark reddish-brown to purplish-black borders (Fig. 12). Infected leaf blades or entire plants may yellow, then turn brown, wither, and die. Girdled leaf blades may drop prematurely.

Crown and root rots usually appear in warm to hot weather as a reddish-brown to black decay of the crown, rhizome, and root tissues. Infected areas may have a general brownish undercast. Such turf is thin and weak, may have a drouth-injured appearance, or may be killed out in round to irregular spots that enlarge during the summer (Fig. 13). The melting-out phase is common when plant vigor is suppressed.

Control: Carry out the cultural practices outlined just above. Kentucky bluegrasses with good resistance to several species of *Helminthosporium* include Warren's A-20 and A-34, Baron, Bonnieblue, Fylking, Merion, Nugget, Pennstar, and Sodco. Kentucky bluegrasses that are commonly damaged by this group of



***Helminthosporium* leaf spots on grass leaves.**

(Fig. 12)

diseases include Cougar, Delta, Kenblue, Newport, and Park. Windsor and Prato are intermediate in their susceptibility. A number of lawn fungicides are effective when applied every 7 to 14 days during wet weather in the spring and fall. Such spray programs, however, are time-consuming, expensive, and often impractical for the average homeowner.

Leaf smuts (stripe and flag)

These two smuts are most evident in spring and fall when pale green to slightly yellowed and stunted plants are seen, singly or in patches a foot or more in diameter. Infected leaves develop long or short yellow-green stripes that soon turn gray. Later the stripes rupture to release a black, soot-like dust. Such leaves quickly twist, curl, and shred from the tip downward (Fig. 14). Smut-infected plants usually die during hot, dry weather.



Serious melting-out in a home lawn.

(Fig. 13)



Bluegrass leaves infected with stripe smut. The two leaves on the right have split into ribbons and are shedding spores. (Courtesy Dr. H. B. Couch)

(Fig. 14)

Control: The cultural practices outlined previously are helpful. The best control is to grow resistant varieties. Kentucky bluegrasses with generally good resistance include Warren's A-20 and A-34, Baron, Delta, Fylking, Kenblue, Park, Pennstar, and Sodco. Very susceptible Kentucky bluegrasses include Cougar, Merion, Newport, Prato, and Windsor.

Powdery mildew

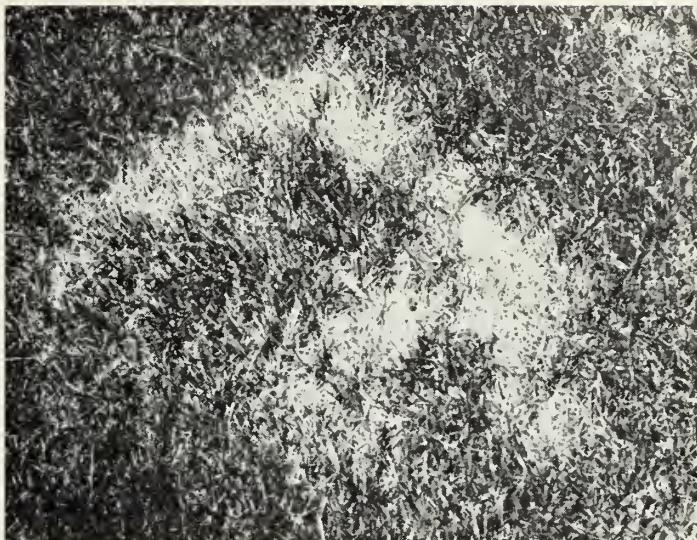
This disease of Kentucky bluegrasses and, to a lesser extent, of fine-leaf fescues is common in the spring and fall when nights are damp and cool and days are mild and cloudy. Superficial white powdery patches of mildew develop on grass leaves, especially in shaded or poorly drained areas (Fig. 15). Heavily infected turf appears dull white, as if dusted with flour. Diseased leaves often turn yellow, wither, and die; growth of leaves, roots, and rhizomes is reduced. When severe, powdery mildew may kill plants, especially in new plantings.

Control: Follow suggested cultural practices. Grow fine-leaf fescues, *Poa trivialis*, or a shade-tolerant ground cover where shade is dense.



Powdery mildew on grass leaves.

(Fig. 15)



Fusarium blight in a Merion bluegrass lawn. (Courtesy Dr. R. E. Partyka)

(Fig. 16)

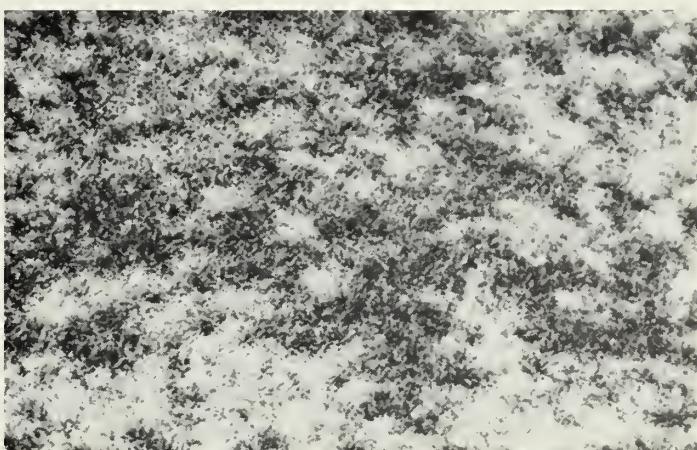
Fusarium blight

This disease is becoming more prevalent and damaging each year during hot, humid weather. Attacks are most serious in sunny, drouthy areas where a thick thatch has developed. Light green patches, up to 6 inches in diameter, appear first. The patches soon turn tan or straw-colored and may develop into streaks, crescents, or circles up to 2 feet in diameter. Within the diseased areas are centers of green, apparently healthy grass, giving characteristic "frogeye" or "doughnut" patterns (Fig. 16).

Control: Follow suggested cultural practices to keep the grass in vigorous growing condition.

Sclerotinia dollar spot

This serious disease of creeping bentgrass, Kentucky bluegrass, fine-leaved fescues, zoysia, and Bermudagrass is active in warm, moist weather in spring, early summer, and fall. On closely cut bentgrass the disease



Sclerotinia dollar spot on closely cut bentgrass. Many of the spots have merged to form irregular areas of straw-colored dead turf.

(Fig. 17)



Sclerotinia dollar spot lesions on bluegrass leaf blades. (Courtesy Dr. D. H. Scott)

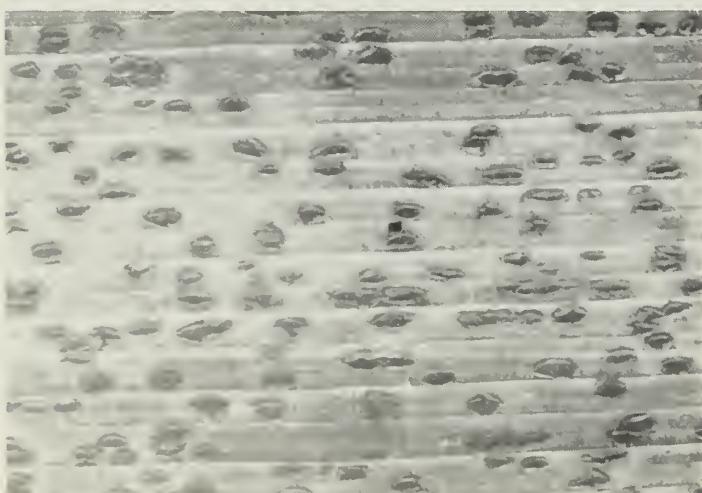
(Fig. 18)

appears as sunken, round, tan to straw-colored spots 1 to 2 inches in diameter — roughly the size of a silver dollar. On Kentucky bluegrass, fine-leaf fescues, higher cut bentgrass, zoysia, and Bermudagrass the spots may reach 4 to 6 inches in diameter. If uncontrolled, the spots may become so numerous that they merge to produce large, irregular sunken areas of straw-colored turf (Fig. 17). Characteristic light tan lesions with dark brown or reddish-brown borders girdle bluegrass leaf blades (Fig. 18) at the margins of the affected areas.

Control: Follow suggested cultural practices. Maintain adequate to high fertility. Where this disease is serious, preventive sprays can be applied during spring and early summer and again in late summer and fall. Start when the disease is *first* evident.

Rusts

All turfgrasses grown in the Midwest are susceptible to one or more rust fungi. Rust is not a problem except during warm to hot dry periods when grass is growing slowly or not at all. Heavily infected grass becomes reddish-brown or yellow-orange because of large numbers of powdery pustules (Fig. 19). The rust material



Rust pustules on a grass leaf.

(Fig. 19)

(countless rust spores) easily rubs off onto fingers, shoes, and clothing. Severe rust infection causes grass blades to turn yellow, wither, and die. Heavily rusted lawns are thinned, weakened, and more susceptible to winterkill, drouth, and other diseases. Some Kentucky bluegrass varieties, such as Merion, Prato, and Windsor, are usually quite susceptible.

Control: Follow suggested cultural practices to produce steady growth in dry weather. Usually an adequate application of nitrogen fertilizer and one or more deep irrigations are sufficient.

Slime molds

These harmless fungi suddenly appear over the grass surface in warm weather after heavy rains or watering. Small watery-white, gray, or cream to yellow slimy masses grow up and over the grass blades in round to irregular patches that shade or even smother otherwise healthy grass. The masses soon dry to form unsightly bluish-gray, grayish-white, black, white, or yellow powdery growths (Fig. 20) that are easily rubbed off.

Control: Slime molds soon disappear when left alone. You can speed the process by raking, brushing, mowing, or hosing down the areas with a stream of water.



Slime mold fruiting on Alta fescue leaves. (Fig. 20)

Fairy rings

Fairy rings usually appear during spring and early summer as circles or arcs of dark green, fast-growing grass. A ring of thin or dead grass may develop both inside and outside this circle. Fairy rings vary in diameter from a few inches to 50 feet or more, but most are 3 to 15 feet across. After rains or heavy sprinkling, large numbers of mushrooms (the fruiting bodies of the fairy ring fungi) may suddenly pop up in the circle outlining the fairy ring (Fig. 21). The lush, dark green grass of a fairy ring is due to the increased amount of nitrogen made available to the

grass roots by the fungus as it breaks down organic matter in the soil. The ring of brown "dormant" grass is caused primarily by temporary exhaustion of soil water and possibly nutrients. The grass in this area may become so weakened that it succumbs to environmental stresses or is killed by other diseases and invaded by weeds.

Control: Rings are usually fewer on fertilized and well-irrigated lawns. Symptoms may be masked by pumping large quantities of water with soil-injection devices into the ring. Treat the rings at the first sign of wilting grass and repeat as often as necessary to maintain color. Complete elimination of the ring is laborious and expensive: the sod must be removed and the soil fumigated or replaced.



Fairy ring in a lawn in dry soil. The ring of thin or dead grass is on the outside, with dark green, fast-growing grass on the inside. (Fig. 21)

LAWN INSECTS

White grubs

The true white grub, which is the larval stage of the June or May beetle, has a white U-shaped body, a brown head, and three pairs of legs. The tip of the abdomen is shiny and transparent. The annual white grub, probably the most common grub found in sod areas, is somewhat smaller in the larval and adult stages than the true white grub. It is especially common in bluegrass sod.

Annual white grubs can be distinguished from true white grubs by a setal pattern on the ventral surface of the last abdominal segment. The true white grub has two rows of spines in the center of this segment, while the annual white grub has a uniform distribution of setae on the segment.

Two other grubs, less common than the ones just described, are sometimes found eating the roots of turfgrass. One, the larva of the Japanese beetle, has two rows of setae in an inverted-V pattern on the underside of the last body segment; the other, the larva

of the green June beetle, has the unusual habit of crawling on its back.

The adult beetle of the true white grub, usually about an inch long, is dark brown to black and has long, slender, spiny legs and a cumbersome body. Adult annual white grubs are small, light tan beetles about $\frac{3}{4}$ inch long; they have two distinct white spots on the abdomen. Japanese beetle adults are about $\frac{5}{8}$ inch long and are metallic green or bronze with reddish wing covers. Green June beetle adults are large, velvety-green and tan beetles about 1 inch long.

True white grubs may have a life cycle of two, three, or four years, but a three-year cycle is the most common. They usually deposit their eggs in grass sods, but one species oviposits in soybean fields. The tiny grubs that hatch from these eggs feed near the surface until the first cold spell in late September or early October; then they tunnel downward, overwintering about 18 inches below the ground surface. In May they return to the surface and feed voraciously on plant roots until the following October, when they again overwinter deep in the soil. The following May, they return to the surface and feed heavily for about three weeks; in early June, they pupate in an earthen cell. Within four weeks they change to adults and emerge to feed and lay eggs.

Annual white grubs, Japanese beetles, and green June beetles have one-year life cycles. All three of these species lay eggs in the soil in June and July. The grubs hatch and feed on decaying organic matter or on grass roots until October, when they tunnel downward. In the spring, they move upward and resume feeding. The grubs pupate in May and emerge as adults in a few weeks.

Grub damage, especially by annual white grubs, is most commonly observed in late summer or fall when the grubs are more than half grown or in the spring when feeding resumes. The roots of established turf are attacked, with damage more concentrated in certain areas of the lawn than in others. The grass roots in



U-shaped white grub in soil.

(Fig. 22)



White grubs sever grass roots so that damaged turf is easily lifted from the soil. (Fig. 23)

affected areas are usually so severely pruned that the sod can be easily lifted from the soil. Green June beetle grubs are more common in areas of the turf that are high in organic matter; these grubs push up mounds of dirt or simply till the infested sod area.

Adults of the true white grub feed on the foliage of trees and shrubs. If beetles are numerous, tree leaves, especially oak, may show extensive damage. Adults of the annual white grub do not feed on foliage. Japanese beetles and green June beetles feed on a variety of plants, including fruits and vegetables.

Areas of turfgrass such as lawns and golf courses are not always seriously attacked by grubs. Most areas can sustain a few grubs per square foot. But in instances of severe infestation, emergency control is difficult unless reseeding or sodding is done. Grub control is probably best done by incorporating a residual insecticide into the soil at the time of establishing a new turf area. The next best method is to drench a residual insecticide into the soil every five years.

Sod webworms

The buff-colored moths of the webworm have a wingspan of about an inch. At rest, the moths look tubular because of the way in which the wings wrap around the body. The moths are flushed from their hiding places when tall grass is mowed or shrubbery is disturbed. They fly jerkily for a few feet and dive to a grass blade to rest. The moths are readily attracted to lights at night. The elongate oval eggs are tiny, dry, and nearly impossible to find.

A sod webworm larva, about an inch long when mature, is gray to dusky-green with a dark brown head and brown spots over its body. The larvae often hide in a silk-lined tunnel in the thatch of the lawn. Larval excrement appears as clusters of small, pale to dark green pellets, some the size of a pinhead. The resting stage between the larva and adult is a brown torpedo-shaped pupa about $\frac{1}{2}$ inch long. When empty, the pupal case looks like a dark brown piece of cellophane.



Irregular brown area in lawn caused by sod webworms. (Fig. 24)

The sod webworm passes the winter as a larva, tightly coiled in a closely woven silk case covered with particles of soil. In the spring, the larva resumes feeding, grows rapidly, and pupates in the cell. In about two weeks—ordinarily about the last week of May in central Illinois—the moths emerge. They emerge in the early evening and mate shortly afterwards.

About a day after emerging, the female moth lays eggs. In hot weather, the eggs hatch in about six days. The larvae require four to five weeks to complete their development; the pupal state lasts eight to 10 days; thus, the entire life cycle usually requires from six to eight weeks so that, under normal conditions, there are two to three generations a year.

Sod webworm larvae feed on bluegrass, orchard grass, timothy, crabgrass, oats, wheat, rye, barley, and corn. They clip the blades of grass just above the sod. Brown spots appear in the turf where the larvae are numerous. These brown areas will usually recover, while similar spots caused by grubs will not.

Webworm control is often too late, being applied after most of the damage has occurred and about the time the worms are ready to stop feeding and pupate. The larva eats about 70 percent of its total food supply in the last 10 days of its development. This is why



Sod webworm adult.

(Fig. 25)



Sod webworm in its burrow in the turf. (Fig. 26)

severe damage can occur within a few days. Early detection, therefore, is important for successful control.

Large numbers of moths flying zigzag just above the grass at dusk and collecting on doors and windows and around outside lights mean that the caution sign should be out. In the central sections of Illinois, moth flights occur between the first week of June and the middle of August. They are heaviest when the first generation moths emerge, in late July and August. Normally, it is at this time that lawns are most seriously damaged and require treatment. Additional moth flights continue well into September. Careful inspection is required to detect the larvae, but this is the only positive means of finding early infestations. A good time to make inspections would be two weeks after a heavy moth flight.

The presence of unusual numbers of birds, especially robins, may indicate an infestation of webworms. By the time the birds invade the lawns, however, the damage is usually already extensive. Furthermore, the webworm larvae are nearly mature, and it is too late to apply chemical control measures. Brown spots are another late indicator of probable webworm infestations, although many other things can cause brown spots in lawns.

A well-kept lawn, fertilized and watered, will support a considerable population of webworms without serious damage. On the other hand, a lawn in poor condition will be more seriously affected by the same number of webworms.

Natural enemies, such as wasps and flies, and diseases kill some webworms but usually not in sufficient numbers to alleviate the problem.

Most chemical controls are applied as sprays, intended to stick to the grass blades where the webworms will feed. A spray-gun attachment on a garden hose is ideal for treatment. Wet the lawn before treating, if adequate amounts of water will not be used during spraying. Do not water for three days after treatment. If rain occurs soon after application, it may be necessary to repeat the treatment.

Armyworms

The armyworm moth, which is about an inch long, is tan to grayish brown and has a tiny white dot in the center of each forewing. With its wings expanded it is about $1\frac{1}{2}$ inches wide. It deposits its eggs—small, white globules—in rows or groups on leaves of grass and rolls the blade around the egg mass. The larva, when fully grown, is about $1\frac{1}{2}$ inches long with two orange stripes on each side. The pupa stays in an earthen cell just below the soil surface.

It is often hard to find armyworms, as they feed at night and hide in the soil or ground cover during the day; for this reason, they are often overlooked.

Few armyworms winter in Illinois. Most of the moths migrate into the state from the south in April and May. The females lay their eggs during these months, and worms of this first generation can usually be found from early May to mid-June. Another generation starts in late June or early July and another in late August or early September. Thus, there may be two or three generations each year.

In Illinois the spring generation is usually the one that is dangerous. Temperatures during the summer favor the spread of a disease that rapidly kills armyworms and greatly reduces the numbers of the second and third generations. The number of armyworm larvae is also reduced by natural parasites—a species of fly and a tiny wasp. When the wasp grubs mature, they emerge and pupate in individual cocoons; masses of these cocoons found in the soil are often mistaken for armyworm eggs.

Cool, wet weather during the spring favors development of armyworms and retards development of the disease and the parasites. Armyworm outbreaks are not so common in warm springs, as this type of weather favors establishment and spread of the parasites and the disease.



Armyworm on plant.

(Fig. 27)

Chinch bugs

The adult chinch bug that damages Illinois lawns has a black body, brown to reddish yellow legs, and white wings that have a triangular black area in the middle of the outer margin. The insect gives off a distinctive foul odor when crushed. The eggs, yellow when first laid, turn red before hatching. They are tiny, elongated, and about four times as long as broad, with four short nipple-like projections on the cap. Although laid singly, they can be found in clusters at the base of the host plants among the roots and soil and also behind the lower leaf sheaths. The nymphs are tiny, red to dark red or nearly black creatures with a yellow to white traverse band on the body. This band remains plainly visible through successive molts even though the body color darkens.

In areas of chinch bug damage to the lawn, grass leaves appear pale green to brown. Upon close examination, small black, red, or black and white bugs will be seen crawling in the affected areas. Some chinch bugs may be seen on the sidewalks or driveways nearby.

Another insect, similar in appearance to a chinch bug, is often present in lawns—the big-eyed bug. About $\frac{1}{8}$ inch long, it has a black body with white wings that lap over the abdomen. The eyes are exceptionally large. It has been assumed that big-eyed bugs are predators of other insects such as aphids; recent evidence, however, indicates that these insects may be sucking plant juices from grass leaves just as chinch bugs do.

Control of chinch bugs is necessary only if damage has been observed and the chinch bugs are numerous. Chinch bugs can be detected by flooding the damaged area. Put water inside a metal ring driven into the soil; chinch bugs, if present, will float to the surface.

Cutworms

More than one cutworm species attacks turfgrasses but the most common is the variegated cutworm. Variegated cutworm larvae live on the soil surface. They feed above ground, commonly crawling up on plants and feeding on the upper leaves. They attack a wide variety of plants, including clovers, alfalfa, corn, vegetables, small and large fruits, tobacco, and even

ornamental plants—particularly in greenhouses. The mature larvae are gray, mottled with dark brown markings, and distinguishable by a row of 4 to 6 small, white to yellow spots down the middle of the back.

These cutworms winter as larvae or pupae. The adults, which are attracted to lights, are grayish or brownish moths, sometimes with distinct markings. They lay their eggs on the stems or leaves of plants, preferably in dense, succulent stands. The small worms mature in 2 weeks to 5 months. There are one to four generations each year. The variegated cutworm does not survive the winter in appreciable numbers in Illinois but instead migrates from more southerly states, where it remains active throughout the year.

Cutworms injure turf by chewing grass leaves off at or near the ground surface.

Leafhoppers

Leafhoppers are winged, wedge-shaped insects about $\frac{1}{8}$ to $\frac{1}{4}$ inch long. When disturbed, they may be found in swarms flying about over a turf area. Leafhoppers usually do not overwinter in Illinois but migrate into the state beginning in May. There are three or four generations each season. Although leafhoppers do feed on grass blades, sucking plant juices from them, the amount of damage rarely justifies chemical control.

Aphids

A species of aphid (plant louse) called the greenbug has been observed infesting turfs in Illinois since 1969. These pale green, soft-bodied, slow-moving aphids are about $\frac{1}{16}$ inch long as an adult. Some of the adults may have two pairs of transparent wings. All stages of growth are present in a colony of greenbugs.

Greenbugs suck plant juices from the leaves of grass. Circular or oval patches of dead or dying grass will appear in the turf area, often beneath a shade tree. The grass blades on the margin of the infested area will be covered by aphids.

Greenbugs do not survive the winter in Illinois, but many migrate into the state as winged adults in the summer. Other host plants include sorghum and small grain crops. Whether the greenbug becomes a more serious pest of turfgrass remains to be seen.

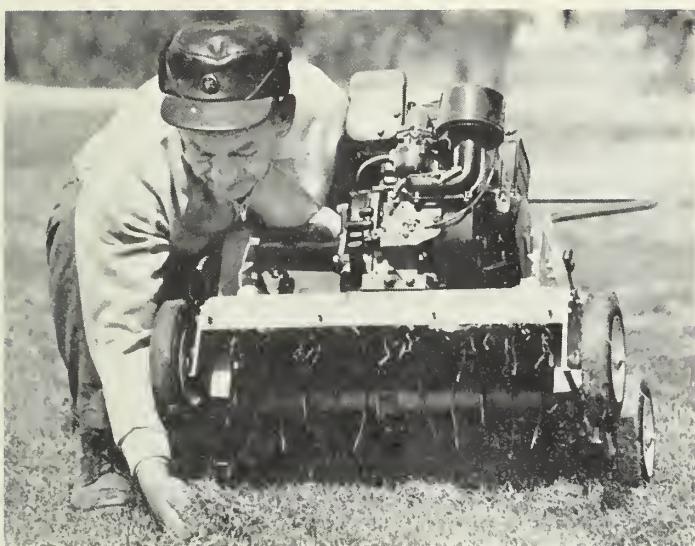
OTHER LAWN PROBLEMS

Thatch

Thatch, a tightly intermingled layer of living and dead stems, leaves, and roots of grasses, develops between the layer of green vegetation and the soil surface. Thatch accumulation, often observed in intensively managed lawns, is undesirable because it increases disease-susceptibility of the grass; reduces tolerance to drought, cold, and heat; impairs the movement of air, water, fertilizer, and some pesticides into the soil; and reduces the lawn's capacity for vigorous growth.

The build-up of thatch is encouraged by vigorously-growing grass varieties, heavy fertilization, excess soil acidity, poor soil aeration and drainage, returning clippings to the turf, and the use of some pesticides. The depth of thatch can be determined by cutting a pie-shaped wedge out of the lawn and examining the profile of green vegetation, thatch, and soil. Thatch $\frac{1}{2}$ inch or more thick can be a serious concern.

Thatch on small areas can be controlled by vigorous hand raking with a stiff garden rake. Various types of



A vertical mower for extracting thatch. (Fig. 28)

machinery for removing thatch employ vertical knives or tines mounted on a power-driven reel to cut and extract organic debris from the lawn. Dethatching machines can be obtained from local equipment rental stores.

Thatch should be removed when climatic conditions favor rapid turf recovery. In Illinois the preferred period is late summer, as the cool, moist weather that follows will enable the grass to heal quickly. Dethatching can also be done during early spring just before the period of rapid leaf growth. Avoid severe dethatching in late spring, as this opens the lawn to invasion by crabgrass and other annual weeds.

Other means of controlling thatch include applying ground agricultural limestone to correct excess soil acidity, avoiding repeated use of pesticides that promote thatch development (chlordan, bandane, and calcium arsenate), and using cultivation practices that alleviate soil compaction.

Soil compaction

Compacted soils are characterized by poor aeration and drainage, low water-infiltration capacity, shallow root growth, and reduced lawn quality. Such soils are typically fine-textured (clay) soils that have been subjected to concentrated traffic.

Soil compaction can be reduced by mechanical cultivation with machines that create openings that extend into the underlying soil, thus facilitating the movement of air, water, and nutrients into the soil. Two principal types of mechanical cultivators are coring machines (aerators) and spikers. Coring machines remove small soil cores, $\frac{1}{4}$ to 1 inch in diameter, and deposit them on the surface of the turf. The cores are then broken up and distributed uniformly over the lawn by a heavy steel mat or section of chain-link fence. The soil should be moist, but not wet, during the coring operation, so that the hollow tines can penetrate the soil to their maximum depth (2 to 4 inches). Spikers and slicers

employ solid knives, which create narrow openings in the lawn; although not as effective as coring machines for reducing soil compaction, they may improve lawn quality on compacted soils.

As with dethatching, cultivation should be practiced during cool weather, when an extended period of active growth follows.

Sod heaving

Small undulations of the lawn's surface may result from winter freezing and thawing or from the activities of earthworms, moles, ants, and other animals. Winter heaving, which frequently occurs on newly established lawns, can usually be corrected by rolling. A water-ballast-type roller is preferred, as the weight can be adjusted by increasing or reducing the amount of water in the roller. A roller one-third filled with water is generally adequate for most uses. To reduce potential soil compaction during rolling, roll when the soil is moist but not wet.

Rolling should not be done as an attempt to correct variations in the surface caused by improper grading during lawn establishment, for continuous rolling will severely compact the soil and substantially reduce lawn quality. The most effective remedy for improper grading is to remove the sod, level the soil, and replace the sod.

Shade

Shaded lawns are usually shallow-rooted, less dense, and more prone to disease than sunny lawns. Kentucky bluegrasses may gradually deteriorate in shade or may fail to establish from seed. Red fescue is the preferred shade grass in Illinois and should be included in the grass seed mixture for shaded areas. Rough bluegrass may do well in wet, shaded areas, provided it does not receive much traffic.

Establishing lawns under deciduous trees should be done in the fall when shading is minimal. Pruning shad-



A core cultivator is used to reduce the effects of soil compaction in the turf. (Fig. 29)

ing trees to allow greater sunlight penetration and better air movement will increase the chances of maintaining turf under trees. Also, pruning shallow tree roots by trenching or other means will reduce competition for water and nutrients. Rake and remove fallen leaves regularly to avoid smothering the grass.

To enhance the survival of shaded red fescue lawns, fertilize them lightly and clip at a relatively high mow-

ing height (2 to 2½ inches). Irrigation should be infrequent, as red fescue does not tolerate persistently wet soil conditions.

Under dense shade conditions, repeated attempts to establish turfgrasses may fail. Consider planting a suitable ground cover (see the following section), or use decorative bark or washed gravel to provide an attractive cover.

GROUND COVERS

There are often areas in the landscape where turf cannot or should not be used; for appearance's sake, however, as well as for erosion control, these areas must be covered. Often, ground covers can be used to solve such problems.

Embankments

Embankments present a special problem. Steep areas are usually dry and constructed of clay fill. If such areas are sunny and not too extensive, there are several good choices. Wintercreeper (*Euonymus fortunei radicans*), lilyturf (*Liriope spicata*), and snow-in-summer (*Euphorbia marginata*) all have a wide range of soil and moisture requirements and do well with minimal maintenance. Creeping juniper (*Juniper horizontalis*) may be used if an embankment is not too steep.

Shady embankments present a different problem. If the area is shady and protected from the wind, good choices are common periwinkle (*Vinca minor*), bugleweed (*Ajuga reptans*), plantain lily (*Hosta decorata*), and English ivy (*Hedera helix*). Japanese spurge (*Pachysandra terminalis*) may be considered if the area is in deep shade and has winter wind protection.

No matter what plant is used, the amount of erosion between planting and establishment of cover is a problem. Using a soil net can help diminish erosion somewhat. Plant more closely on slopes than on flat areas.



English ivy makes a good ground cover for shaded sites. When established, it will climb up trees, masonry walls, and other surfaces, but it can be kept in check by annual pruning. (Fig. 30)

Fertilizer is the best and least expensive aid for establishing ground cover on slopes. It should be applied before planting, according to soil test results and plant requirements. Several applications of a low analysis fertilizer throughout the growing season are recommended, since water carries off much of the surface-applied nutrients. Mulch, which holds moisture near the surface while the ground cover becomes established, is also well worth the expense of application.

Enclosed areas

Enclosed areas, such as islands in patios, circle drives, or areas between entrance sidewalks and the house, allow use of aggressively growing ground covers such as creeping phlox (*Phlox subulata*) and goutweed (*Aegopodium podagraria*) that would otherwise invade turf areas. On the other hand, Longwood's euonymus (*Euonymus fortunei 'Longwood'*), mother-of-thyme (*Thymus serpyllum*), wild ginger (*Asarum canadense*), bunchberry (*Cornus canadensis*), and pachistima (*Pachistima canbyi*) are planted in enclosed areas to protect them from being encroached upon by grass.

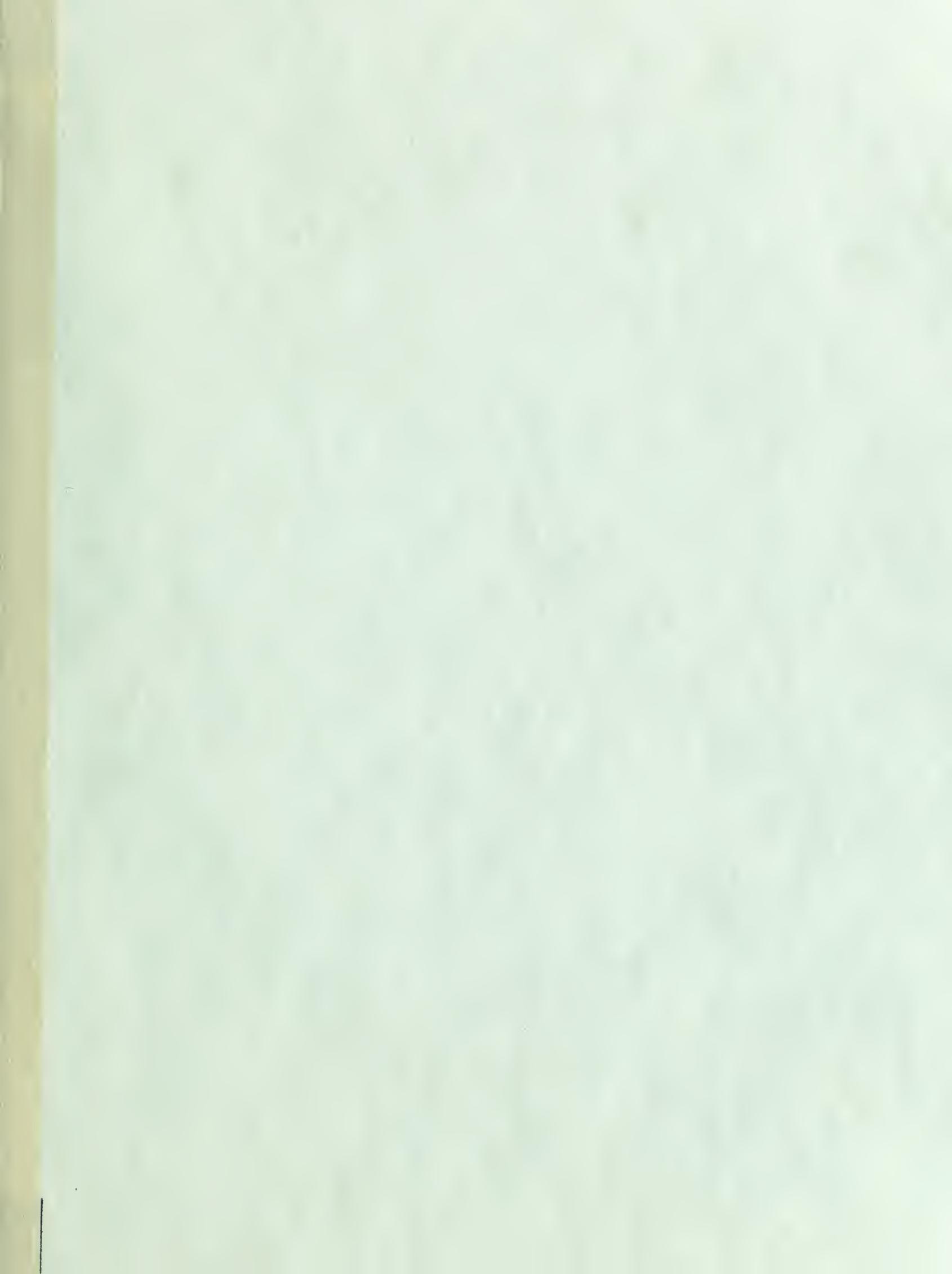
Shaded areas

Areas under large old trees, on the north side of buildings, or in other shaded conditions may best be handled with one of the following ground covers. Periwinkle, bugleweed, English ivy, and plantain lily make good covers if water can be supplied or if the area is naturally moist. In areas that will remain dry because of dense root growth and little water, good choices are wintercreeper, purpleleaf wintercreeper (*Euonymus fortunei 'Coloratus'*), goutweed, wineleaf cinquefoil (*Potentilla tridentata*), pachistima, and creeping potentilla (*Potentilla verna*); English ivy does well in dry areas if it receives water while becoming established.

Barren strawberries (*Waldsteinia fragarioides*), daylilies (*Hemerocallis* species), wild ginger, and bunchberry will do well in groves of small trees or flowering trees, especially in good soil or in soil that has been improved with fertilizer and mulch.

In areas where the soil has a low pH, such as in rhododendron or azalea beds, wineleaf cinquefoil is a good choice. Periwinkle and English ivy also tolerate acid soils and blend well with broadleaf evergreens.





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